AGRICULTURAL NEWS LETTER

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This publication contains information regarding new developments of interest to agriculture based on laboratory and field investigations of the du Pont Company and its subsidiary companies. It also contains published reports and direct contributions of investigators of agricultural experiment stations and other institutions as related to the Company's products and other subjects of agricultural interest.

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AGRICULTURAL NEWS LETTER

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Agricultural News Letter (du Pont)
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RESEARCH DEVELOPS NEW USE FOR UREA WHICH PROVES TO BE VALUABLE AID IN LUMBER SEASONING ON WEST COAST

EDITOR'S NOTE: Urea, a white, odorless, crystalline solid, manufactured synthetically by the du Pont Company at Belle, West Virginia, has established itself as an important industrial chemical. It is extensively used in such fields as medicine and commercial fertilizers; in fermentation processes; and in the manufacture of adhesives, plastics, and dyes, to name only a few. Research has now developed a new use for Crystal Urea. A progress report by L. A. Nelson, head of the West Coast Lumbermen's Association's Department of Grades and Inspection, under whose supervision extensive tests were made, presents data showing that urea is valuable as an aid in lumber seasoning. This report, which was printed in the December, 1939, issue of "West Coast Lumberman", pages 10-14, is reviewed briefly in the following article.

Chemical seasoning is the process of controlling seasoning degrade by the application of water-soluble substances to the surface of green lumber, which is to be air or kiln dried. The outer surface remains moist during the drying process and the drying proceeds from the inside out, the surface drying last. This reversal of the natural course of drying reduces the stresses responsible for checking, splitting, and honeycombing, and permits faster and more severe kiln schedules, thus increasing the kiln capacity.

Extended laboratory and mill tests show that of many substances considered for the chemical seasoning of lumber, du Pont Crystal Urea is superior because of a number of important factors. It effectively reduces seasoning degrades; and treated lumber after drying does not dampen under conditions of high humidity; it is not corrosive to metals used with wood; it is stable, non-toxic, and harmless; and retards fungus and rot attack; it does not discolor lumber, has no action on tools or knives employed in dressing lumber, and has flame-retardant action; it is commercially available and low in cost.

Chemical seasoning with urea is being used in mill-scale treatments on Douglas Fir, Hemlock, and Red Cypress, and tests are under way on a number of other woods. L. A. Nelson, of the West Coast Lumbermen's Association, in summarizing his work with Douglas Fir and West Coast Hemlock, states that, while more study and experience are needed to master the art of using urea to aid lumber seasoning, "we believe it established that any effects of urea upon lumber are beneficial, and that positive benefit in preventing checking can be obtained from the dry-spreading method--with care in piling to keep a heavy concentration of the chemical in the surface shell of the lumber".

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Mill Experience

The tests conducted by the Association have been supplemented by experiments with urea on the part of a number of West Coast mills. Mr. Nelson's report states that such mill tests are most helpful in developing knowledge of chemical seasoning.

He points out that one mill successfully treated three cars of 8" x 16" - 28' Select Structural Stringers, and is now treating two more cars. Urea was applied dry, with bulk piling, and then strip piling for a period. Another mill treated 6" x 8" and 8" x 10" Clears and air seasoned these with satisfactory results. This mill also treated 6" x 6" and 8" x 8" Clears, which were subsequently kiln dried with no fall-down.

Another mill having difficulty in seasoning 3" x 8" to 16" Clears tried urea treatment with such satisfactory results that it is now their standard practice.

At one mill 6" x 6", 8" x 10" and 12" x 14" Select Structural were dry-treated with urea. The 6" x 6" was kiln dried to 12 per cent moisture content. The other sizes were placed in a structure on the outside of a building without drying, and after one year of exposure show no checking.

Nine pieces of 12" x 30" - 45', seven of them boxed-heart, were dry treated and placed in a school building. No checks developed for eight months. Summer weather caused an open check at one end of a boxed-heart piece, slight or hair-line checks on other boxed-heart pieces; no checks on side-cut pieces.

Urea is Non-Corrosive -- Harmless to Skin

Mr. Nelson, in his report, says that since urea is not corrosive, timber so treated can be used with metal fasteners without fear of injury. He also points out that it is harmless to the human skin, even having medicinal or healing properties.

Adds to Natural Durability of Treated Wood

Tests made to determine the toxicity of urea to fungi most damaging to Douglas Fir, showed that "urea has a moderately toxic effect and adds to the natural durability of the wood treated".

Care of Lumber and Various Treating Methods:

The report goes into considerable detail on the care of lumber in treatment. It explains various treating methods, including soaking, dry-spreading, and spraying; as well as kiln drying after treatment, and coating. It discusses such important factors as cost of urea treatment, and outlines experimental procedure and results.

Effect of Urea Treatment on Checking

The report points out that the Association's study was aimed primarily to develop methods of chemical seasoning adapted to dimension and timbers which

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go to the trade and into use without kiln drying. However, a number of kiln-drying tests of lumber into which urea had been diffused by the usual bulk piling were made to develop the possibilities of urea as an aid in kiln drying; and to learn more about the whole subject.

The results were uniformly good in minimizing checking. Pieces treated with urea came through the kilns uniformly in better condition than untreated controls subjected to the same schedules. Dry spreading proved the most dependable application of chemical prior to kiln drying, in order to get the urea where most needed--on the face, at the ends, and along the middle of the width of each piece.

The report states, "As would be expected the results in kiln drying, urea-treated lumber were more satisfactory and more uniform than those obtained in air drying". This, it points out, is because of the controlled temperatures and particularly the controlled relative humidities, possible only in kiln drying.

Kiln-drying time is shortened by urea treatment and more severe drying schedules can be used. For example, 4" x 12" was dried to a moisture content of 13.3 per cent in 10-1/2 days. For many items, the shortening of drying time will probably pay the cost of chemical treatment. The report says that "one of the most profitable fields for exploration in chemical aids to lumber seasoning is the use of urea in kiln drying difficult items, as a means of shortening schedules, and in reducing checking, loosening of knots, and other forms of degrade."

The Association's Recommendations

Mr. Nelson, in summarizing the Association's recommendations, concludes with this statement:

> "We recommend the use of urea by West Coast lumber manufacturers for any items where the cost is justified. This may be to overcome present unsatisfactory results in either air or kiln drying, or unsatisfactory service to the buyer--in the condition of lumber when received or after put in use. We recommend urea particularly for thick or wide Clear items; Select Structural items - such as railroad stringers; Lamella Blanks, trusses, and like structures. We recommend it, in fact, for any item where the delivery of a check-free product is worth the cost of urea treatment to the manufacturer".

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TESTS SHOW "CELLOPHANE" HELPS PRESERVE WEIGHT, COLOR, TURGIDITY, TEXTURE, FLAVOR, AND PALATABILITY OF CUCUMBERS

EDITOR'S NOTE: Experiments conducted by the Texas Agricultural Experiment Station have resulted in the discovery of practical methods to preserve weight, color, turgidity, texture, flavor, and palatability of cucumbers grown at College Station and Winter Haven. While the work was confined to cucumbers, the results, together with those of other recent tests, indicate the value of moisture-proof "Cellophane" cellulose film as individual wrappers or liners in shipping containers for commercial purposes, to preserve freshness and lengthen the life of fresh fruits and vegetables. The following are excerpts from Texas Agricultural Experiment Station Bulletin 576, outlining the methods of the investigation and summarizing the results.

Among the treatments giving protection to individual fruits, were wrappers of four grades of "Cellophane" (PT, plain transparent, SST and SAT intermediate grades; MT, moistureproof transparent), waxed paper such as is used for bread; disinfecting with a solution of chlorinated lime before wrapping in MT "Cellophane", the stem having been removed from some fruits during harvest but not others; spraying with paraffin.

* * *

Only two varieties, Early Fortune and Kirby Stays Green, equally distributed, were employed the same season. Thereafter but one variety, either Kirby Stays Green or Early Fortune was used any season, with the possible exception of some mixing in the commercial seeds used.

In all cases the fruits were weighed, labeled and placed in storage as promptly as possible; locally grown fruits were stored within a few hours after harvesting. Fruits prepared at Winter Haven for storage at College Station were shipped by express on the day of harvesting and were received at College Station some 48 hours later. They were promptly reweighed individually and placed in storage.

In each storage period, the cucumbers handled individually weighed at frequent intervals; at Winter Haven daily as they neared 90%, and again as they neared 85% of original weight; at College Station fruits were weighed every other day for the first two weeks, and thereafter twice weekly until they were considered unsalable and for this reason discarded.

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At Winter Haven in the same year, all the fruits in a given treatment were weighed as one lot, in most instances, every other day, but a few times after an interval of three to five days. Sample fruits from each treatment were taken from time to time for tasting and judging the several points of quality desired by producer, distributor and consumer.

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Results

Loss in Weight - The first tests at Winter Haven showed that unwrapped fruits which had lost 15% of their original weight were usually unfit for use, and some had a decided lack of turgidity which made them unsalable. Therefore, a loss of 15% in weight was made the basis for discarding fruits at the Substation and record was kept to determine when they had lost only 10% in weight.

* * *

Effect of Storage on Eating Quality

Method of Judging - Sample fruits of every treatment both at Winter Haven and College Station were tasted at intervals. Observations at Winter Haven were in the nature of an over-all judgment of palatability while those at College Station dealt with the several qualities individually. Four aspects of quality - turgidity (firmness), texture (crispness and tenderness), flavor and palatability (flavor, texture, turgidity, odor, considered together) - were rated independently by each of six judges using a score card especially devised for the purpose. The predominating color inside and outside was noted and any departure from the judge's idea of normal color was mentioned. Salability was considered to be no departure from normal shape, color, odor and firmness that would prevent the cucumber being bought in the market. Edibility was thought of as being fit to be eaten, whether or not the fruit was more or less pleasing to the palate.

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That loss in weight is not directly associated with eating quality so long as fruits are desirable at all, is evident in both the cucumbers from Winter Haven and those from College Station.

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The range of loss of weight in three of the treatments of fruits from Winter Haven is practically the same, and the other two treatments resemble each other; but differences in the time during which the fruits in the five treatments remained in good condition are clear cut.

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Lack of correlation between rating of odor and palatability is noteworthy. Although many of the fruits with low palatability scores, especially those stored long periods, have a low rating on odor, this was not consistently so. A number of fruits with high palatability had low odor rating, and high odor rating sometimes accompanied a low palatability score.

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Summary and Conclusions

In this study extending over five seasons, cucumbers grown at Winter Haven and at College Station have been stored for varying periods of time.

Out of 18 treatments tried, three were found equally satisfactory for preservation at once of weight, color, turgidity, texture, flavor and palatability of cucumbers held in storage at 40° F. In one treatment the fresh cucumbers were wrapped individually in moistureproof "Cellophane"; in another packed unwrapped in large light-weight wood or corrugated paper containers lined with moistureproof "Cellophane"; in the third the unwrapped fruits were placed in a refrigerator humidifier. For at least eight to ten days these methods kept cucumbers practically as good as fresh and up to two weeks quite acceptable, though not all of them were in excellent condition. Since cucumbers constitute a decidedly seasonal crop, satisfactory methods of preserving freshness may have considerable value to producer, distributor, and consumer. Use of moistureproof "Cellophane" as individual wrappers or liners in shipping containers may be recommended for commercial purposes; the refrigerator humidifier for use in the home.

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Note: The word "Cellophane" is a trade-mark of E. I. du Pont de Nemours & Co.

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PRELIMINARY TESTS CONDUCTED TO EVALUATE ACTION OF SULFAMATES AS WEED KILLERS

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EDITOR'S NOTE: The following is not intended to offer conclusive results, but is merely a preliminary report of progress regarding the possibilities of sulfamates as weed killers. It is hoped that this report will create interest among investigators who are qualified to evaluate these new industrial chemicals under a wider range of conditions. To that end, the Grasselli Department of the du Pont Company is furnishing moderate quantities to such recognized investigators for experimental purposes.

During the summer of 1939, the authors carried out a series of preliminary tests to evaluate the action of sulfamic acid and certain of its salts as weed killers. Although it was reported about 43 years ago that certain sulfamates had an objectionable action on growing wheat and barley sprouts, no further observations in this field have been published since that time; (J.Chem.Soc. 69, 1662 (1896); Brit.Chem.Hbst. 72, 279 (1897).

A few preliminary tests on small plots, 8 feet square and covered with mixed annual weeds, indicated that solid ammonium sulfamate and solid sulfamic acid applied by simple hand spreading were much more effective as weed killers on a weight basis than solid sodium chloride and approximately equal to sodium chlorate. Additional tests were therefore undertaken using solutions of known concentration applied by pressure spraying to plots which were closely similar in weed coverage. These plots located along an old fence had been cut over annually for several years, were 5 x 8 ft. in size, and contained a variety of annual and perennial weeds, including ragweed, wild parsnip, wild daisy, and considerable poison ivy.

A series of simple comparisons indicated that concentrations of from one-half to one pound of ammonium sulfamate per gallon of water were most convenient for use, and that an application at the rate of ten pounds of the salt per 1,000 square feet was adequate in most cases for practically a complete kill. Further work is necessary to determine optimum concentrations to obtain selective action on weeds without affecting desired crop growth. Comparative tests showed that at equal concentrations, sodium sulfamate was slightly less effective than ammonium sulfamate while calcium sulfamate showed little action. Ammonium sulfamate at the above concentrations appeared to be just as effective as sodium chlorate at the same concentrations. Sulfamic acid applied in

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solid form at the rate of about 25 pounds per 1,000 square feet was highly effective as a weed killer, but when applied as a 4 per cent aqueous solution at the lower rate of about 3 pounds per 1,000 square feet it was considerably less effective although slightly better than 4 per cent sulfuric acid solution applied at the same concentration.

The foregoing comparisons were made in Delaware during the month of July. Because the applications were made quite late in the growing season, it is not known definitely whether the killing effect included any permanent injury to the root systems, although no appreciable new growth appeared on properly treated test plots. Further observation of the initial test plots will be necessary before extensive conclusions are made. It was observed, however, that ordinary poison ivy was particularly sensitive to the ammonium sulfamate spray treatment, and that no appreciable new growth appeared even though certain applications were made early in July and in some cases carried out only three hours before a heavy rain. It is possible that the high solubility of ammonium sulfamate and its known compatibility with cellulose (Ind.Eng.Chem. 31, 1237 (1939) may be important factors in its weed-killing action.

The fire hazard associated with sodium chlorate is eliminated by ammonium sulfamate which in turn has a fire-retardant effect even though it is present in low concentration. Moreover, sulfamate salts are believed to be entirely nontoxic to animals. It is, of course, too early to predict the ultimate effect of sulfamates and sulfamic acid on the soil. However, as sulfamic acid is slowly hydrolyzed to ammonium acid sulfate and because sulfamates can be utilized by bacteria, it appears that there would be no danger of an extended sterilization of the soil. Sulfamic acid and its salts are now produced on an increasing commercial scale, and it is anticipated that the cost will ultimately be within a range permitting quite general use as weed-killing chemicals.

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NEW LABORATORY BEING CONSTRUCTED FOR RESEARCH ON INSECTICIDES AND FUMIGANTS

A new laboratory for research on insecticides and fungicides is being constructed for the Grasselli Pest Control Research Section of E. I. du Pont de Nemours & Company, at the Experimental Station of the company, Wilmington, Delaware. The building will be one of the few biological laboratories in the country devoted exclusively to this type of research.

It will be a three-story brick and tile structure 38 x 50 feet, conforming to the architectural style of the other buildings at the du Pont Experimental Station. It is expected the building will be completed in July.

Lethal chambers, all types of equipment for applying chemicals to insects and fungi will be included in the new building. Complete facilities for the rearing of test insects, fungi, and bacteria under carefully controlled conditions will be provided. To test new possibilities for insecticides, fungicides and bactericides, elaborate humidity and temperature control equipment will be installed in order to duplicate the conditions under which these pests thrive and multiply.

Special chambers will be provided for testing both stomach and contact insecticides for chewing and sucking pests. Turntables, spraying and dusting equipment will be used to secure uniform distribution of accurately measured quantities of chemicals over the leaves of vegetable and ornamental plants.

The temperature and humidity control both in the rearing and testing chambers are necessary to obtain accurate results with insecticides and fungicides.

Provision will be made for rearing insects so that they will be healthy and maintain a high resistance to insecticides. Fungi will be kept under the best cultural conditions for tests.

Research will be carried out on glue, paints, rope, canvas, textiles, timber and other cellulose products which are subject to attack and deterioration by fungi and bacteria.

Fully equipped rooms will be provided for chemical and physical studies on insecticides and fungicides and other pest control problems. Offices and a library reference room will be included.

The Pest Control Laboratory is now housed in a temporary building. The increased demand for the products and the scope of the research undertaken, however, has forced the construction of a larger laboratory.

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STUDY OF STATE FERTILIZER CONTROL BULLETINS SHOWS THAT MANY CONTAIN USEFUL SUPPLEMENTAL INFORMATION

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EDITOR'S NOTE: Commercial fertilizers are subject to rigid inspection and control. All States require guarantees of composition and plant-food content. Thousands of samples are collected each year by State inspectors for chemical analysis by the State Control Chemist's office. Results are published in Fertilizer Control Bulletins. All States issue such reports, but many State Control Officials, either working alone or with the State Agricultural Experiment Station staff, include additional facts regarding the composition of fertilizers, trends toward higher grades, costs, and other supplemental information of considerable value to the fertilizer industry and to farmers. The following study of a number of current State Control Bulletins indicates the possibilities in this connection.

A State Control Bulletin carrying a report of the official chemical analysis of thousands of samples of fertilizers, while important to the fertilizer industry and the farmer, makes rather monotonous reading. Many State Control Chemists restrict their published reports to the statistics required by law. The usual practice is to publish the fertilizer manufacturer's firm name and address, followed by the "guaranteed" and "found" plant food of each sample. The official analysis usually indicates that guarantees are met or exceeded. Such minor discrepancies as do occur indicate little or no intentional attempt to violate control regulations.

Fertilizer manufacturers make considerable use of these State Control Bulletins, and farmers often refer to them before deciding on their fertilizer purchases. With such circulation and use, the Official Control Bulletins become exceptionally suitable media for presenting other data relating to fertilizers. A study of recent issues of these Bulletins shows that this fact is recognized by many States, which now include valuable supplemental information, as reviewed in the following discussion.

Information on Plant-Food Costs

A recent consumer survey conducted by The National Fertilizer Association brought out the fact that many farmers continue to buy fertilizers on the basis of cost

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per ton. Some Control Bulletins are helping to clarify this matter by carrying information which will undoubtedly help teach consumers to think in terms of "cost per pound of plant food" rather than "cost per ton of fertilizer".

For instance, a recent Vermont Control Bulletin includes the following table, giving information which shows that, since 1934 there has been a gradual increase in the plant-food content in each ton of fertilizer used in that State, with a consequent reduction in the cost per pound of plant food:

	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
Approx. average retail price (per ton)	$44	$45	$36	$34	$39	$36	$40	$41	$42	$42
Approx. average pounds plant food (per ton)	435	433	432	453	424	434	438	471	482	480
Approx. average price per pound of plant food (cents)	10.1	10.4	8.3	7.5	9.2	8.3	9.1	8.7	8.7	8.8

An Indiana Bulletin shows the cost of plant food has declined from a high of 11.6 cents per pound in 1920 to 8.0 cents in 1930 and 6.5 cents in 1937.

Facts on Concentration and Its Relation to Cost

Many Control Bulletins include information on plant-food concentration and its relation to fertilizer cost. For example, a South Carolina Bulletin shows the savings obtained by using a 4-12-4 instead of the old 3-8-3. One ton of 3-8-3 supplies 280 pounds of plant food at a cost of $23.67. But 1400 pounds of 4-12-4, which costs $28.13, per ton, will supply the same quantity of plant food at a cost of only $21.09, or at a saving of $2.58.

A Texas Control Bulletin presents cost figures for equivalent amounts of plant food supplied in fertilizers of three different concentrations, as follows:

Tons	Grade	Cost
1.67	3-10-3	$48.13
1.25	4-12-4	41.27
1.00	5-15-5	39.22

Vermont includes a table showing that the plant-food costs decrease as the concentration of the fertilizer increases. Thus, the average cost is 10.6 cents per pound of plant food in fertilizers containing 15 to 17 units, compared with 9.5 cents per pound when the concentration is increased to 20 or 21 units. The cost reaches a low of 6.5 cents per pound of plant food in grades containing 38 to 44 units. The South Carolina Bulletin quoted previously demonstrates

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that the cost of fertilizer to the consumer is determined by two major factors:

1. The wholesale cost of materials
2. The cost of manufacture and distribution.

The cost of manufacture and distribution is approximately the same regardless of the concentration. The fertilizer consumer can do relatively little to reduce these cost factors, but by spreading these costs over a larger number of units per ton (higher concentration), some real savings result. The inclusion of this type of information is of especial value to farmers who do not understand the difference between price per ton and price per unit of plant food.

Data Help Grade-Reduction Program

Many State Control Bulletins include articles and appropriate illustrative tables and charts on the number and tonnage of fertilizer grades. This helps to educate the consumer and to promote the program of grade reduction which has been started in many States.

One finds, for example, that recent Control Bulletins report that over 80 grades were sold in Massachusetts, of which only five or six grades supplied well over 90 per cent of the total used in that State; and that 160 grades were sold in Virginia, where only about ten grades were needed to supply over three-fourths of the total used. This is true in many other States, where a large percentage of the total is confined to a few grades, with a large number of other grades accounting for only a small tonnage each.

Agronomists quite generally agree that a relatively small number of fertilizer grades in any one State is adequate for all possible variations of crops and of soil conditions. It is also agreed that a reduction in grades tends to reduce fertilizer-manufacturing costs. A multiplicity of grades is said to confuse rather than to help farmers.

Importance of Basicity of Fertilizers

Many States now require a guarantee of the acidity or basicity of fertilizers, and report the results of their inspection for this factor in their Control Bulletins. Some other States, not required by law to make this determination, report acidity as a service to the consumer. Regardless of whether a State is required by law to report on acidity or basicity, explanations of the value of non-acidforming fertilizers will undoubtedly increase the demand for this type of fertilizer for most crops. The additional calcium and magnesium supplied by the limestone in neutral fertilizers usually makes them more efficient.

The Massachusetts Control Bulletin takes advantage of the opportunity to report that the average acidity of fertilizers in that State has declined from 235 pounds per ton (expressed in terms of calcium carbonate) in 1934 to 109 pounds in 1937. Vermont presents data showing that it would require an application of 526 tons of limestone to neutralize the acidity developed by the 7,821 tons of complete fertilizer sold during the year, and concludes that "it can be readily seen that the use of the average complete fertilizer sold in Vermont tends to induce soil acidity." It then gives this sound advice: "Farmers who

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buy brands which tend to increase soil acidity will do well to use lime". This supplemental discussion makes dead statistics come to life; makes them useful and instructive.

Great Variety of Supplemental Facts Being Presented

Some States, notably Massachusetts and Texas, make a practice of regularly inspecting and appraising the value of new materials offered for consideration of consumers. The report is made in their Control Bulletins. Massachusetts, for instance, has compared the nitrogen availability in various forms of natural organics.

The wide variety of subjects discussed in some Control Bulletins can be seen from the following headings, picked at random:

Definitions of Fertilizer Materials and Terms
Acid-Base Balance in Mixed Fertilizers
Quality of Plant Food
Fertilizer Grades and Price Data
What Does One Get in Modern Commercial Fertilizer?
Fertilizer Should Be Purchased on Basis of Plant Food
Why 16 Units or More?
Recommended Fertilizer Ratios and Analysis
The Method, Time, and Rate of Applying Fertilizers.

Bulletins containing such information are rendering real service to the farmer-consumer. He is usually plentifully supplied with sales propaganda, continually visited by salesmen, and often perplexed by the large number of grades offered for use on a particular crop. Unbiased information supplied by his Control Bulletin may very well assist the consumer in making an intelligent purchase.

Some States Have Shown the Way

For a variety of useful information the Bulletins of Massachusetts, Texas, Indiana, and Vermont can hardly be surpassed. As indicated in the foregoing discussion, others have also made considerable progress. These Control Officials are to be commended for the excellent use they have made of the opportunity to present facts other than routine analytical reports. The inclusion of this valuable supplemental information requires only a few additional pages, and enhances the value of the Bulletin manyfold.

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EFFECTS OF LEAD IN THE DIET OF RATS

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The Division of Animal Nutrition and the Department of Horticulture of the University of Illinois have recently published results of interesting investigations dealing with the assimilation and retention of lead by rats and the effects of apple constituents on the retention by growing rats of lead contained in spray residues resulting from the spraying of apples with arsenate of lead for insect control. The purpose of these studies was to obtain further information with regard to any possible effects on human health of the lead consumed by eating apples sprayed with arsenate of lead. The investigators and authors of the two papers dealing with the subject are J. B. Shields, H. H. Mitchell, and W. A. Ruth.

The first of these papers (The Metabolism and Retention of Lead in Growing and Adult Rats, "Jour. Ind. Hygiene and Toxicology," Vol. 21, No. 1, Jan. 1939) is concerned with the relationship between the lead content of the diet and the retention of lead in the bodies of albino rats which were used for the investigation. There were questions, the answers to which the investigators felt would have a bearing on the health hazards of dietary lead in human nutrition. These questions were: (1) Does lead accumulate more rapidly in the young animal in which bone growth is still proceeding than in mature animals? (2) Is the body able to excrete lead as rapidly as it is absorbed from the gas-tro-intestinal tract at certain low levels of intake, or is a proportion of the incoming lead stored at all levels of intake?

Rats for the experiments were carefully selected with regard to litters or groups, age, and weight, and then paired. They were fed rations containing graded amounts of acid arsenate of lead. At the beginning of each experiment representative rats from each litter or group were sacrificed for chemical analysis. The experimental pairs of rats were continued on equated intakes of food until 500 grams or, with most pairs, 1000 grams of food were consumed. They were then sacrificed with ether and their bodies analyzed for lead. Every possible care was taken to eliminate all sources of lead except that taken in the diet. A thorough and complete study of these experimental rats, including the chemical analyses, resulted in the following conclusions:

1. During the period of rapid growth, the rat accumulates lead in its body, probably in its skeleton, at such low levels of intake as 2 p.p.m. (parts per million) of dry food. As the concentration of lead in the food is raised by additions of acid lead arsenate up to 80 p.p.m. the retention of lead increases in a parallel fashion.

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2. Compared with rats in the later stages of growth or with mature rats, the young growing rat retains much more of a given intake of lead as the acid arsenate or from a given concentration of lead in the food.

3. Mature rats and rats in the later stages of growth will not accumulate lead in their bodies at an appreciable rate until a certain critical concentration of lead in the food is reached. Under the conditions of this experiment, and with reference to the acid arsenate of lead, this critical concentration lies between 32 and 48 mgm. per kgm. of dry food.

4. Under the conditions of these experiments, the concentration of lead in the bodies of mature or nearly mature rats could not be raised above 9 to 9.5 p.p.m. by the feeding of lead arsenate. With young growing rats the concentration of lead in the body could be raised to a level of two to three times this value.

5. The storage of lead in rats, if the storage is accumulated during the period of rapid growth, is quite stable, and, for reasons given in the text, probably more stable than body lead accumulated during maturity.

6. Lead is not absorbed from the stomach, but is actively absorbed throughout the small intestine and possibly also in the cecum and colon.

7. Most of the lead excreted from the body during a period of lead feeding with the acid arsenate of lead leaves the body by way of the intestinal tract. On a ration containing 50 p.p.m. of lead in the above form, only about 10% of the excreted lead appeared in the urine.

In their second paper (The Effect of Apple Constituents on the Retention by Growing Rats of Lead contained in Spray Residues, "Jour. Nutrition," Vol. 18, No. 1, July 10, 1939) the authors discuss the known value of fruit and especially apples in the diet. Pectin, a constituent of apples, is known to play an important part in this favorable action. Pectin in the form of apple powder is known to be much more efficacious than commercial pectin. Apple powder has a favorable influence on the bacterial action of the digestive tract and aids in the detoxication mechanism of the body.

These desirable properties commend the apple for food. However, apples are being marketed with residues of acid lead arsenate which is used as sprays for insect control. Although the permissible amounts of residual lead and arsenic on commercial apples are under the control of the Federal Food and Drug Administration in the case of interstate shipment and of state agencies in a number of states, the situation is not entirely a satisfactory one, and many attempts have been made and are being made to alarm the consumer and discourage the buying of apples.

In view of the known favorable effects of apples in the diet, it occurred to the authors that possibly the constituents of the apple would absorb the lead contained on its surface or in some way inhibit or impede its absorption from the intestinal tract and thus diminish the possibility of a harmful effect. It seemed likely that the pectic or hemicellulosic constituents might have this effect, since pectic acid solutions are precipitated by lead, calcium and barium.

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In order to test this theory, feeding experiments were conducted with young rats. Some of them were fed: (1) on an artificial diet which was complete and equal to the apple diet in calcium and phosphorus; (2) some on apple powder from apples sprayed with acid lead arsenate, and (3) some on powder made from unsprayed apples. The lead content of all three diets was made the same. Acid lead arsenate was added to diets (1) and (3) to make the lead content equal to that of diet (2); after the feeding was continued for a satisfactory period of time the rats were sacrificed for chemical analysis. A number of check rats were sacrificed at the beginning of the experiment for comparative analyses for lead. Care was exercised to avoid the entrance into the analyses and calculation of lead from sources other than the supplied diets.

The following conclusions were drawn by the authors as a result of these experiments:

1. No evidence was obtained that the lead occurring in the spray residue on apples is any more or less assimilable by the growing rat than the lead contained in $PbHAsO_4$, the original spray chemical.

2. There exists in the apple a substance or substances capable of depressing considerably the assimilability of lead. Under the conditions of this experiment the depression averaged 37%. Quite probably this depression in assimilability (retention in the body) relates to absorption from the intestinal tract only, and may be brought about by the pectic constituents of the apple. It seems quite likely that it would be greater with apples containing a smaller proportion of lead to solids than the apples used in this experiment, in which the proportion was more than four times that permissible in interstate commerce.

3. It would appear that feeding experiments concerned with the possible toxicity of lead in lead arsenate spray residues on fruits should involve the feeding of rations containing the fruit solids, unless it can be shown that the fruit itself does not modify the assimilability of the lead.

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Paper on Outstanding Developments in Fungicides Available Upon Request

On November 15, 1939, W. H. Tisdale presented before the Phytopathological Seminar of the U. S. Department of Agriculture a paper entitled "Recent Advances in the Development of Fungicides." This paper summarizes the outstanding developments in fungicides over a period of the last twenty years. A number of pathologists in the Department of Agriculture suggested that the paper be published. It is now available in mimeographed form to those who send requests to the Department of Public Relations of the Du Pont Company, Wilmington, Delaware.

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TWO DECADES OF PROGRESS IN FINISHES

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EDITOR'S NOTE: Revolutionary changes have been made in the finishes industry since 1918; some developments are reviewed here.

Like the making of an automobile, the manufacture of finishes is a business of assembly. But - instead of engines, transmissions, bodies and other units - the maker of finishes works with such things as pigments, vehicles and solvents. So to fully appreciate the growth of this industry, with its annual production valued at $500,000,000, we must first know something of the development in these raw materials.

The period during the past twenty years has been one of marked evolution. New pigments, new film-forming materials, new solvents were developed - sometimes within the industry, in other cases by independent suppliers. But with all the changes and improvements little good would come to the industry without equipment and facilities for evaluating and using these raw materials.

Twenty years ago, research was largely concentrated in the laboratories of pigment and oil suppliers. Today, manufacturers within the industry have well-equipped research organizations and trained chemists, who, because of their studies and findings, have made possible the use of materials and production methods previously unthought of. Where once manufacturing processes were performed on a rule-of-thumb basis, now they are under exacting chemical control with the result that the elimination of guesswork has benefited both the maker and user. Products of uniformly high quality are now being offered with competent technical service to insure correct application and better results.

In short, the past twenty years have witnessed the renaissance of this industry into a live, well-organized, highly-competitive chemical business in which keen scientists are vieing with each other to produce better finishes at less cost and to make them available to the public. What all this has meant to the ultimate consumer cannot be estimated, but some of the effects will be noted in this review. Before getting into that story let us see how these products serve.

Finishes are surface coatings applied for protection, for decoration, or both. In the case of structural steel, protection is the major factor. Finishes for houses must be both protective and decorative, as are those for automobiles,

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refrigerators, metal fixtures and furniture in households. And material costs, application costs and service requirements are usually the controlling factors.

In general a finish is made up of three parts - pigment, binder, and solvent. The first provides obscuring value and decoration, and in some cases protection as well. The second holds the pigment particles together and to the surface being coated. Obviously, the life of the binder controls the life of the film. The function of the third is to put the actual film composition in a physical condition to be applied conveniently to the surface. While all this sounds relatively simple, manufacturing modern finishes is full of complexities that only those in the industry can realize or appreciate.

Twenty years ago the white pigments in use consisted of white lead, zinc oxide, and to some extent lithopone. Colored pigments were for the most part chemical dry colors such as the lead chromates, Prussian Blue, various iron oxides and a few lake colors. Today, the industry has, in addition, antimony oxide, many varieties of lithopone, titanium oxide and all of its varieties, chromium oxides and hydrates, and a host of organic colors.

Twenty years ago the binders - raw or heat-treated linseed oil and China wood oil - were used in combination with natural and fossilized resins. We still use these oils, but four more have been added to the list. We still use rosin and its derivative, ester gum, but rosin hardened with phenol formaldehyde has largely pushed fossil resins out, and nitrocellulose combined with various plasticizers, and synthetic resins have come prominently into the picture.

Twenty years ago, mineral spirits constituted the principal solvent of the industry, with turpentine still an important factor. In use today are many chemically-made solvents that were entirely unknown two decades ago.

In short, the paint industry now has literally thousands of materials from which to select. It is not exceptional for a large paint house to use upwards of 1,000 raw materials in its current manufacture. Considering the color variations of finished products and packaging requirements ranging from half-pint cans to tank cars, a modern paint manufacturer may be called upon to supply perhaps 20,000 different items.

First shock to the old finishes industry came in the early 1900's when China wood oil became a standard commodity. This material, because of its rapid-drying properties, encouraged industrial customers to believe that possibly finishing schedules could be sped up enough to make mass-production methods possible. At that time, too, certain pioneer chemists began the foundation work on which has been built the present substantial industry.

In 1919, one side-line business of the chemical industry was the manufacture of nitrocellulose lacquers. Ten establishments in that year made and sold about a half million gallons of the product for such minor uses as the coating of metal hardware and gas mantles. Only thin films of lacquer could be applied, and the material was too expensive for general use. Thick films were needed, but efforts to increase the solubility of nitrocellulose by chemical treatments were of little avail, for the films resulting were too brittle. So the prospects for expanding the use of lacquers seemed limited.

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Two years later chemists learned how to treat nitrocellulose and smokeless powder so as to produce thicker and more flexible films of lacquer. The following tabulation shows the result - a phenomenal upsurge in production and sales.

LACQUERS

	No. of Establishments	Gallons of Lacquer and Lacquer Thinner	Value	% of Total Finishes
1919	10	500,000	$ 923,464	0.27
1921	17	1,409,280	3,093,862	1.30
1923	41	3,255,857	6,944,366	1.72
1925	106	12,267,206	27,254,796	5.71
1927	175	30,386,168	60,269,673	12.42
1929	206	45,702,055	82,336,227	16.20
1937	206	46,817,113	72,361,461	....

(Figures from Biennial Census Reports)

Prior to 1921 the automobile industry had been trying to fit its finishing system to a mass production basis. It had already forced down the drying time of existing varnish enamels below the danger point, from the standpoint of protection and retained appearance, without attaining the objective. Like a drowning man reaching for a straw, automotive manufacturers seized on the newly-developed lacquers. "Duco" finish, quick-drying, durable and outstandingly attractive, met the need. Extremely rapid finishing schedules were adopted and the finishing methods of the industry were completely revolutionized.

By 1927, the new lacquers were also being used on furniture, mechanized refrigerators and many metal and wooden objects. They were even made and sold for brush application in the home. All this stimulated many finishes manufacturers to form chemical organizations. Lacquers were improved and there was a tremendous expansion in the production of processing materials. Colored enamels that dried quickly were developed and new types of varnishes. Materials which were unused previously in the finishes industry now found places in the formulas of many products of the better kind.

A few years before the Du Pont Company began research with the idea of producing better resins for use in nitrocellulose lacquers. Early in this work, however, it was discovered that modifications of glyceryl phthalate with the acids of drying oils add interesting film-forming properties in themselves. By 1928 enamels based on these resins - popularly called alkyds - had appeared on the market. Here was another revolutionary finish, now trade-marked "Dulux," which, like "Duco," was to win high place among the new products of the finishing industry. By 1936 it had completely replaced lacquers in the refrigerator field and was rapidly gaining ground in competition with porcelain finishes. Its initial high gloss and durability early recommended "Dulux" enamels for finishing commercial cars and refinishing automobiles. It was also used for factory finishing of several well-known makes of cars. From then on it was only a short transition to the manufacture

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of finishes for structural steel, signs, machinery and many other articles such as typewriters and kitchen furniture. Later, high-grade household and architectural enamels of this type came on the market. The statistical picture of the alkyd resins is shown in the accompanying table.

Practically all of this production was consumed in finishes - and their estimated value for the year 1937 has been computed to be not less than $50,000,000.

ALKYD RESINS

	No. of Makers	Pounds Produced
Prior to 1929	1	Relatively Small
1929	3	1,000,000 (estimated)
1933	6	9,930,705
1934	10	15,299,247
1935	15	34,312,713
1936	31	46,952,452
1937	39	61,254,019

(Figures from Report No. 131, U. S. Tariff Commission)

A direct by-product of this development was the introduction into the industry of large quantities of high-solvency petroleum solvents, to supplement the inadequate supplies of aromatics. Coincidentally, there also came on the market new-type varnishes made from phenolic compounds and various aldehydes dissolved in China wood oil. The use of these materials has grown steadily. While volume output is much smaller than that of the lacquers or the alkyd products, the special properties of these varnishes have made them well suited for use under severe exposures, such as under water and where extreme alkali and acid conditions are present.

The most recent of the important additions to the binder picture lies in the urea-formaldehyde resin field. This resin had been used for years in plastics, but had resisted attempts to make it sufficiently soluble for finishes. In addition, it was extremely brittle, a fault requiring correction. Du Pont chemists undertook the task and succeeded in producing synthetic resins of this type with improved properties in both respects. The first commercial finishes containing them appeared on the market in 1937. When baked they set quickly and give promise of becoming important in industries employing mass production methods.

Since then an enormous amount of additional research on synthetic resins has been under way, with the result that many new binder materials have been made and evaluated. The work is still in progress with little likelihood that the saturation point on resin developments will be reached in our day. Obviously, the field for investigation is still large and activity is keen.

While new binding agents have profoundly influenced the course of the finishing industry during the past two decades, corresponding developments in the pigments field have contributed to the progress that has been made. In this connection the following tabulation, taken from U. S. Bureau of Mines and Tariff Commission publications, indicates the domestic output of the more commonly used white

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pigments since the year 1927. Unfortunately, information on titanium pigments is not available.

White Pigments

Short Tons of Production

Year	White Lead	Zinc Oxide	Leaded Zinc Oxide	Lithopone
1927..........	151,695	151,246	26,064	176,994
1929..........	147,031	160,611	27,149	206,315
1931..........	97,368	95,700	18,577	151,850
1933..........	72,982	98,542	22,868	140,831
1935..........	96,831	99,697	29,976	159,486
1937..........	98,213	114,652	40,343	154,771
1938..........	96,800	79,100	38,200	124,900

Of course, not all of this production was used in finishes. Much of it was consumed by the floor-covering, rubber and other industries. But if one could see the statistical picture of these pigments for paint-making uses alone during this period, it would show lithopone replacing white lead, and in more recent years titanium pigments gaining ground at the expense of both. The reason, of course, is its intense whiteness and hiding power approximately three times that of the others. These pigments have come into extensive use, first in gloss finishes for one-coat purposes, in the alkyd finishes mentioned, later in the gloss and flat wall finishes and still later in the house paint field. Research and scientific production have thus brought to the trade and to consumers a large number of better and more serviceable white pigments than were available even five years ago. Through the cooperative efforts of pigment suppliers and finish manufacturers color pigments have also been improved.

This story would not be complete without some reference to the advances made in manufacturing processes. Twenty years ago a well-equipped paint maker had a number of Buhrstone mills for grinding, with perhaps a simple roller mill for grinding flat paints. Mixing was done in small units, often by hand. His vehicles were supplied from small coal-fired open varnish kettles, and the varnish makers were a law unto themselves. Filling, too, was usually done by hand. Today, factories are equipped with ball and pebble mills, or with high-speed five-roll mills. Heavy duty mechanical dough mixers are often in use, and the kettles for making varnish or resin are indirectly heated and elaborately equipped with operating controls. Modern materials, machines, and methods all contribute to efficient and economical production today.

No major product of the finishes industry has remained untouched by changes during the past two decades. House paints are more durable, look better and are better values than ever before. Interior enamels and wall finishes hide better, dry faster, are made in a wider range of dependable colors than ever before, and the same is true of finishes for fabricated wood, metal articles, furniture, refrigerators, automobiles and almost everything else that needs protection or decoration. The finishing industry has gone far and will go further in manufacturing quality products and in broadening its field of service.

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Note: The word "Dulux" is a registered trade-mark of E. I. du Pont de Nemours & Company.

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A NEW FLY SPRAY

Science News Letter, December 16, 1939, p. 392 under title "New Family of Chemicals Parade at New York Show" states - - "Any new use for castor oil to divert it from the use that you think of when you hear the name is news. Castor oil is being used to make paint, replacing tung oil largely imported from China and now difficult to get on account of the Japanese invasion."

To this important new use for castor oil may be added another valuable discovery involving the use of castor oil. Large quantities of pyrethrum obtained from a species of chrysanthemum plant are used in suitable hydrocarbon oil bases as fly sprays. The most important of the chief sources of pyrethrum is Japan and, as in the case of tung oil, the supply is adversely influenced by the war. Castor oil again comes to the rescue.

Castor oil when subjected to heat is broken down into undecylenic acid, heptaldehyde and residues. The undecylenic acid is separated by distillation and treated with isobutylamine to form isobutyl undecylenamide. This, when used in combination with small amounts of pyrethrum in a suitable base oil, is an excellent fly spray, better than either pyrethrum alone in the base oil, or isobutyl undecylenamide alone. Synergism appears to be demonstrated by the mixture. The isobutyl undecylenamide replaces about two-thirds of the pyrethrum formerly used and represents about one-half per cent in the spray. In addition to the superior killing properties of the mixture, the castor oil derivative has the advantage of being a stable compound that can be manufactured according to specification. This in contrast to pyrethrum which is unstable and uncertain as to quality and supply. Extensive commercial use has proved the high efficiency of this fly spray which was previously shown experimentally.

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